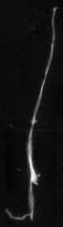

IN THE PURSUIT OF

Achievements in development research supported by the International Development Research Centre and the Swedish Agency for Research Cooperation with Developing Countries

Knowledge in the Pursuit of Change

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Foreword

While over 90 percent of financial resources for development comes from the developing countries themselves, funding from external agencies such as SAREC and IDRC, which support development research, have been shown to contribute significantly to the development effort. The global amount of money available for development, including research, however, continues to fall far short of what is required; thus, it becomes more important than ever that those agencies and organizations involved in this effort take stock regularly of progress made and of the factors that affect progress — or the lack of it.

The material in this booklet is a by-product of a continuing evaluation process to determine what has been achieved through research and what future programs need in order to be more effective. From detailed case studies, we learn more about the larger process of development and the role research can play within that process. By presenting examples from two agencies side by side, we hope to create a unique record of successful, complementary research activities supported by two very different agencies. We hope to encourage development organizations to increase the complementarity among their programs, in harmony with the activities of national and regional organizations, so that the potential effectiveness of their respective contributions will grow.

Research, even under the best of conditions, is a difficult, complex, and often protracted activity. Results often overturn initial expectations. Conditions in the developing world can magnify the obstacles and uncertainties many times over. From the point of view of those who would evaluate progress, research is a dynamic activity that is never "finished." Solutions often generate new sets of problems. Thus, to remain vital and effective, we must continually evaluate progress, adjusting our objectives and our methods when necessary.

This booklet, then, is an attempt to communicate to our colleagues and to our constituencies, both at home and around the world, something of the uniqueness of approach that our two organizations have brought to the field of development assistance, and to demonstrate what can be achieved through research. We hope that it also conveys a sense of the challenge in the research process, and the excitement that comes from contributing to the advancement of knowledge as well as providing tangible solutions for improving conditions in developing countries.

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Introduction

We live in an inequitable world. Wealth, population, health, resources — all are unequally divided between the industrialized nations of the North and the developing nations of the South. The biggest gap between North and South, however, is in the area of science and technology. All but a tiny percentage of scientific research (estimates range from 95 to 98 percent) is carried out by the nations of the North. Lacking this vital capacity for research, the nations of the South have little hope of developing the technologies they need to tackle their problems in their own way.

Until quite recently, it was generally assumed that the technologies of the North could simply be transferred to the South. However, experience has demonstrated that the process is much more complicated than that. All technologies are to some extent dependent on the culture and the environment that created them. The transfer of a technology must, therefore, involve some degree of adaptation if it is to be effective in meeting local needs. This process should involve research scientists in the recipient country, working in their own institutions. Also, it is often wrongly assumed that all technologies originate in the North. Despite limited resources, a great deal of scientific innovation takes place in the developing world. If these countries are to succeed in overcoming the obstacles to development, they need both the human and financial resources to increase their capacity for relevant scientific research.

It was an awareness of this need that led to the establishment in Canada in 1970 of the International Development Research Centre (IDRC) and in Sweden, 5 years later, of the Swedish Agency for Research Cooperation with Developing Countries (SAREC). The two agencies are similar in both outlook and objectives. Their programs are designed to promote research that contributes to the development of the nations of the South; in particular, research that is aimed at meeting the basic requirements of those in greatest need. Both agencies place a strong emphasis on increasing the research capacity of recipient countries, both through direct funding of projects, institutional grants, and through support for research training programs and advanced education.

Over the years, IDRC and SAREC have collaborated in many research efforts, often involving one or more other donor agencies, and they continue to do so. This booklet is a first effort, however, at collaboration in the field of communication. It contains brief reports on 28 projects supported either entirely or in part by IDRC or by SAREC. With several thousand projects to choose from, the selection included here cannot be said to be representative. Rather, it provides a cross-section of research projects large and small, offering the reader a sense of the range, the variety, and the richness of research experience that the two agencies have accumulated in their collaborations with the scientists of the South.

Science and technology hold out much promise to the developing countries — the promise to grow more and better food, to improve health, and to provide clean water, adequate shelter, education, and employment — as these stories clearly show. There is also the promise that, as the scientific capacity of the nations of the South develops, those nations will become equal partners in a world where technology is used only for positive means, and the scientific exchange of ideas flows in both directions.

Improving Health

Many factors contribute to deteriorating health conditions in the developing world. They include inadequate water supply and sanitation, lack of facilities and trained health-care professionals, malnutrition caused by famine and both natural and man-made disasters, and the constant threat of tropical diseases, to which has been added in the past decade the world-wide spread of AIDS. These factors have their greatest impact on the poor in developing countries.

Much innovative medical research is taking place in the developing world, where limited resources force people to do more with less. Many tropical plants are sources of medications for everything from tranquillizers to blood pressure treatment, and the potential is only beginning to be explored. Yet, only 4 percent of the money earmarked for health research throughout the world is spent in developing countries.

This section offers a few examples of promising health research in Africa, Asia, Latin America, and the Middle East — as well as offering valuable lessons for the nations of the North.

An Effective Anti-Cholera Vaccine

The most common causes of illness and death among children in the developing world are diarrhoeal diseases caused by bacterial infections of the gut. The most dangerous of these is cholera, a disease that also levies a heavy toll on the adult population.

Since the early 1960s, cholera has been winning the battle, particularly in Southeast Asia. Many severe epidemics have also been reported in Africa, and, more recently, in South America. Many millions of people contract cholera every year and hundreds of thousands die.

Cholera is highly infectious. It is spread through water or food contaminated by bacteria from infected feces. The most effective means of combating the disease are better hygiene and separate systems for drinking water and sewage. It was these very measures that led to its eradication in Sweden, where cholera was a dreaded scourge well into the mid-19th century.

In developing countries, however, access to clean drinking water is directly linked with poverty and the distribution of limited resources. These are complex socio-economic issues that are amenable only to long-term

solutions. In the short term, people are dying. For the foreseeable future, therefore, the struggle against cholera must be aimed at protecting people against existing sources of infection.

So far, there has been no really effective cholera vaccine; the current vaccine provides only limited protection for 3 to 6 months. This may be good enough for tourists; but, for those living in the developing world, the vaccine is neither effective nor affordable.

Things may soon improve, however. A new and considerably more effective cholera vaccine has been developed through SAREC financing. During field trials in Bangladesh, the incidence of fatal diarrhoeal diseases was almost cut in half. Moreover, there are indications that the vaccine gives significant protection against cholera for longer than the 3-year period the trials were designed for.

No side effects from the vaccine have so far been detected. Also, the fact that it can be taken in the form of a fizzy drink means it is a great deal cheaper and safer to administer. Hygiene problems normally accompanying the use of hypodermic needles in poorer countries — including the risk of jaundice and HIV (human immunodeficiency virus) infection — are avoided altogether.

The new vaccine is the result of more than 10 years' collaboration between the Department of Medical Microbiology at the University of Gothenburg and the International Centre for Diarrhoeal Disease Research (ICDDR,B) in Dhaka, the capital of Bangladesh.

The vaccine is already being registered as a medical drug in many countries. Current development work is concentrating on reducing production costs and simplifying its manufacture. In theory, the technology for this already exists; plans are under way for a more advanced version of the vaccine — due to be ready for production within the next 3 years — that can be produced cheaply by the developing countries themselves. Production of a simpler version has already begun on a limited scale in Southeast Asia.

Combating AIDS in Tanzania

The first AIDS case in Tanzania was reported in 1983. By 1985, the number of cases being reported was growing at an alarming rate, and it was clear that the country had a serious public health problem on its hands. But that was the only thing that was clear.

The total number of cases of HIV infection was unknown, as were its geographical and demographic distributions. This lack of relevant data imposed severe limits on any hopes of applying effective countermeasures.

Bilateral research cooperation with Sweden into this difficult and sensitive matter began on a modest scale in 1986 with support from SAREC. Since then, it has grown rapidly. Today, it involves 10 institutes in Tanzania and 4 in Sweden, including the Department of Epidemiology and Health Care Research at the University of Umeå. The collaboration has already yielded concrete results at various levels and significantly enhanced Tanzania's ability to combat AIDS.

The first tasks were to extend laboratory capacity at the central hospital in Dar es Salaam, Tanzania, so that blood donors could be tested for HIV infection, and provide on-site training in the methods being used. Next, researchers began extensive screening of selected population groups — including "bar girls" and pregnant women living in the capital city — and a general survey of the spread of infection in the hardest hit area, the Kagera region in the northwest.

These measures provided researchers with a new understanding of the extent and patterns of HIV infection in the country. The work also helped to develop some national expertise in the fields of microbiology and immunology.

Another urgent task was to evaluate a range of HIV/AIDS tests available on the international market to determine the most reliable tests for African blood serum. In Africa, the frequency of false positive test results (results falsely indicating the presence of the disease) has been fairly high. Apart from the considerable personal anxiety this causes, it means that blood banks are compelled to dump blood unnecessarily or stop taking donations altogether. The hospitals' choice of test procedure is, therefore, critical.

Often there may be no hospital in the area at all, and occasions requiring immediate HIV testing might well arise, for example, when an injured or seriously ill person living in a rural area urgently needs a blood transfusion. Accordingly, researchers have also directed their attention to very simple tests capable of producing results within a few minutes without the need for laboratory analysis (see the next article, "The HIV Dipstick").

An important but unexpected discovery was made by researchers when testing severely undernourished children undergoing hospital treatment. Every fourth child was found to be HIV-positive, a finding not only of vital relevance to continued treatment but also for the future diagnosis of children in whom undernourishment is a primary symptom. Studies of behaviour-related risk factors among the Kagera population have also yielded important information. Of the adult urban population in the region, 25 percent were found to carry HIV. In the surrounding rural areas, the corresponding value was 10 percent.

The researchers continue to attack the problem on many fronts, with the overall aim of promoting appropriate measures and increasing levels of competence within the country. A central task will be to follow up the large Kagera study to determine how quickly (and by what paths) infection has continued to spread in the region. Another urgent task involves developing methods for determining as rapidly as possible whether young children of HIV-positive mothers also carry the virus. Unfortunately, the blood tests currently available are not reliable in children under 18 months of age.

The HIV Dipstick

Health experts now rank AIDS as the most serious epidemic of the past 50 years. Although accurate figures on the extent of the epidemic are impossible to obtain, conservative estimates are that as many as 10 million people in more than 70 countries may already be infected with HIV. Perhaps 30 percent of those carrying HIV will likely develop AIDS within 5 to 10 years. Worse, because the majority of HIV carriers are undiagnosed, they may unwittingly pass on the virus to many others.

There is as yet no cure for AIDS and no vaccine to provide protection. So prevention — always a vital step in limiting the spread of infectious diseases — takes on even greater significance. A key preventive measure is to identify those individuals who are already infected, but, until recently, this required an expensive test procedure that could take as long as 24 hours to produce a result.

The problem is particularly acute in developing countries, where the possibility of wide-scale HIV screening is constrained by lack of resources and trained personnel as well as by cost. Now, a reliable test is available for use in developing countries that is safe, costs only 25 cents, doesn't require expensive equipment or highly skilled technicians, and produces results in minutes instead of hours.

Called the HIV dipstick, it was developed by researchers at the Program for Applied Technology in Health (PATH), in Seattle, Washington, with support from IDRC. Simply put, the test uses a stick of polystyrene that has been sensitized with a synthetic chemical compound derived from HIV. A small amount of blood serum or plasma is placed on the stick, and treated with a reagent. If antibodies to HIV are present in the sample, a red spot appears on the stick. The presence of antibodies indicates that the person being tested is carrying HIV. Although slightly less sensitive than the existing tests, which are designed to detect the virus in low-risk populations, the dipstick is ideal for use in populations where the need for sensitivity is lower because the risk of HIV infection is high, as is the case in many developing countries.

The entire test takes less than half an hour to perform and interpret. This can often be a critical factor in countries where there are few blood-banking facilities. Under these circumstances, medical staff must be able to determine if a potential donor's blood is "safe" in as short a time as possible to safeguard the patient who will receive the transfusion. Or, perhaps the results are needed quickly because the patient has to travel many hours to get to the clinic where the testing is carried out, and can't simply "come back tomorrow" for the results.

Once PATH had developed the dipstick technology in its own labs, the research moved to Thailand. Working with the Thai Red Cross Society, tests were conducted on blood samples taken from participants in a rehabilita-

tion program for intravenous drug users. Thai health officials estimate that as much as 60 percent of intravenous drug users are HIV positive. One of the Society's staff, Khun Sunee Sirivichayakul, spent 3 months in Seattle learning how the dipsticks were manufactured. When she returned to Thailand, she helped establish a pilot manufacturing operation for the dipsticks.

The next step for PATH and IDRC is to introduce the technology in Africa, which is one the regions of the developing world hardest hit by HIV. The dipstick is a small but significant weapon in the world-wide war against AIDS.

Promising Cancer Research in Cuba

In Cuba, many of the health problems still besetting the developing world — such as undernourishment, lack of clean drinking water, and high incidence of infectious diseases — have been brought under control. Mortality rates have fallen, and there has been a corresponding rise in life expectancy. However, the country still faces a major health problem: cancer. Today in Cuba, breast cancer is the most common disease, as well as the most common cause of death, among women.

The accelerated development in advanced cancer research during the last decade in Cuba should be seen against this background. A recent basic research project on breast cancer carried out at the Cuban Research Institute, INOR, in collaboration with the Department of Tumor Pathology at the Karolinska Institute in Stockholm has resulted in a number of important discoveries.

About 20 years ago, tumors in certain women suffering from breast cancer were found to contain so-called estrogen receptors: proteins capable of binding estrogen (the female hormone). Estrogen receptors were identified as an important factor in tumor growth. Efforts then turned to developing a drug that would check growth by blocking the receptors.

Such a drug would offer a far less drastic alternative to standard chemotherapy treatment, with its numerous side effects and potential for impairing the bone marrow's capacity to produce blood.

However, trial results showed that receptor blockers were, for the most part, effective only in older women. The explanation lies partly in the high estrogen levels of premenopausal women, which prevent the treatment from working properly, and partly in the fact that tumors in younger women usually lack estrogen receptors. It was evident that the development of breast cancer in younger women — whose tumors are usually more dangerous — was governed by some other mechanism.

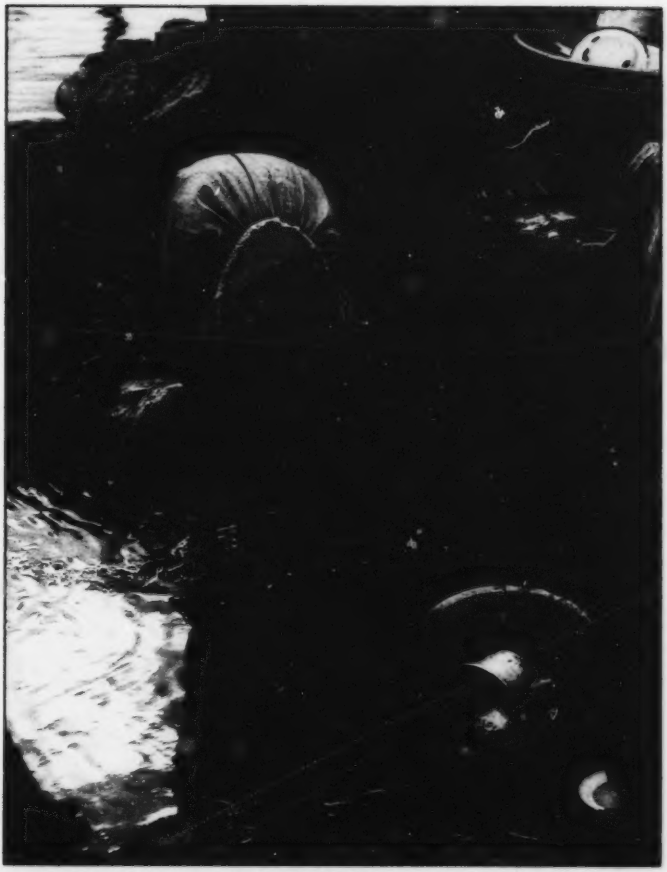
It is here that the SAREC-supported Cuban–Swedish breast cancer research project has made an important contribution. After many years' work (beginning in 1982), researchers have now identified a receptor for a hitherto unknown substance known as EGF, which seems to regulate the growth of breast cancer tumors in women of childbearing age.

The discovery could have long-term practical implications for the treatment of breast cancer in younger women. By combining cytotoxins (or "cell poisons") with substances that bind to the newly discovered receptors, researchers are now attempting to influence tumor cells without the risk of injuring the rest of the body.

Breaking the Cycle of Disease

The land of the Nile Delta north of the ancient Egyptian capital city of Cairo is flat and fertile. The countryside is laced with a network of canals, the larger ones still plied by the elegant, sail-powered barges called *dhows*. The smallest canals irrigate the fields that make this the most productive agricultural region in the country. On the banks of the canals are hundreds of villages. Here, the canals also bring death and disease.

The situation is the same here as in many developing countries — the World Health Organization has estimated that 80 percent of all seriously debilitating and fatal disease is related to the interlinked problems of water supply and poor sanitation. The worst sufferers are children. In this region of Egypt, the infant mortality rate is as high as 8 percent. Most of those deaths can be traced to problems of water and sanitation. Attempts by government agencies to deal with the problem had failed. In fact,



Washing cooking utensils in canal water — perpetuating the cycle of disease in rural Egypt.

the situation was deteriorating as many of the villages faced increasing population and a measure of urbanization that placed even greater stress on already inadequate facilities.

Earlier studies had shown that the problem is not simply one of inadequate facilities such as poor sewage and drainage, contaminated water supply, and inade-

quate sanitation systems. The villagers, and sometimes even the local health personnel, had no understanding of the links between personal hygiene, water, and sanitation, and little knowledge of what is needed to maintain a healthy environment in the home and in the village.

So, in 1985, with support from SAREC, researchers at the Social Research Centre of the American University in Cairo set out to study the root causes of the problem in an attempt to develop new methods for improving the situation. The research team, headed by social anthropologist Samiha El-Katsha, was made up entirely of women, and it was to the village women that they turned their attention, realizing that women are the key link in breaking the cycle of disease. Convincing the women that things can be changed was the team's first goal. The second was to involve the women in the process leading to change.

The project has been remarkably successful. In the first phase, researchers surveyed thousands of women in the villages of Babel and Kafr Shanawan to determine their understanding of, and attitudes to, the problems. In each of the two villages they identified and trained "communicators," each responsible for about 30 households. These were local people who became community activists and involved the village women in discussion groups in homes, clinics, and schools. Once they had faced the issues and brought them out in the open for discussion, the women began to propose solutions.

In the second phase of the project, many of the ideas that emerged from these groups were implemented in the two villages. The goal was to involve all the community — village leaders, health and sanitation workers, men, women, and, especially, children. In a novel hygiene education program, the children act as agents of change, bringing the lessons learned daily in the classroom into the home. The lessons learned at Babel and Kafr Shanawan will soon be taught in villages throughout the region, bringing hope for an end at last to an age-old problem.

Increasing the Food Supply

Food and nutrition are essential to a healthy population. As many developing countries have demonstrated over the past few decades, they can provide enough food to feed their people, and sometimes even for export. The trick is to discover the right combinations of the the right varieties of the right crops for the local conditions. Much has been learned since the development of the high-yielding wheat and rice varieties that were the foundation of the "Green Revolution," and researchers in agriculture, nutrition, and the sciences of soil and water face many challenges.

Not the least of those challenges is to combat the depletion of the forests and the spread of the deserts. New agricultural techniques combined with forestry can perhaps turn the arid lands green again. It is a battle in which both North and South have a vital stake.

The projects in this section describe just a few of the ways in which developing-world researchers are attempting to provide more food in sustainable systems to meet the needs of growing populations.

Support for International Agricultural Research

The Consultative Group on International Agricultural Research (CGIAR) is an association of 15 international agricultural research centres (IARCs), most of them based in the developing world, and each specializing in its own field of research — crop-specific research, research on agriculture in dry areas, livestock rearing, agricultural economics, etc. Both SAREC and IDRC have provided substantial support for CGIAR over the years and continue to be major supporters of this important organization.

The combination of improved varieties of rice, maize, and wheat, as well as better cultivation techniques and farming systems secured stable food resources for an additional 500 million people in the developing world between 1965 and 1985. Today, more than half the area devoted to rice and wheat farming in the developing world is sown with improved cereal strains from the IARCs.

One CGIAR centre is responsible for the collection and analysis of plant genetic material and the maintenance of genetic resource banks for food crops such as rice, beans, cassava, millet, sorghum, and potatoes. The task is not only of immense importance for continued plant breeding work but also promotes and facilitates the exchange of scientific information among researchers active in different parts of the world. Still another centre specializes in support for national agricultural research programs, ensuring that researchers in individual developing countries have access to the resources and results available through the IARC network.

Among other achievements in recent years, CGIAR has succeeded in developing a new variety of potato seed as a viable replacement for conventional potato tubers, which create serious storage problems for poor smallholders. CGIAR has also been successful in breeding a new type of cassava, which is a staple crop in many parts of the developing world, and a particularly important food source in arid climates.

For some time now, researchers at the CGIAR centres have devoted increasing attention to the problems of natural resource management and sustainable production, a focus that is expected to continue as the CGIAR

expands to encompass several more specialized centres in the 1990s, including centres for forestry, agroforestry, and aquaculture.

New Fish in Old Ponds

Fish farmers in China and other Asian countries have been reaping harvests from their ponds for thousands of years. Yet, in all that time, the fish that they farm have changed very little. Whereas modern breeding techniques have improved cattle, poultry, and crops almost beyond recognition, there's been precious little improvement in the fish pond.

The key to the problem is that most fish don't breed well in captivity, the conditions just aren't right. So, at regular intervals, the fish farmer and his family take their nets and go hunting for fry — tiny immature fish — with which to stock their ponds. Irregular supply by this method makes it difficult to run a successful aquaculture operation. Research supported by IDRC is taking a two-pronged approach to solving the problem: improving the breeding and improving the breed.

A breakthrough in fish breeding occurred in 1977 at the Southeast Asian Fisheries Development Centre (SEAFDEC) in the Philippines. SEAFDEC's researchers succeeded in breeding milkfish in captivity for the first time, using artificial fertilization. Milkfish are a favourite

Harvesting milkfish at a commercial fish farm in the Philippines — benefiting from a breakthrough in fish-breeding technology.

food of millions of Asians, providing as much as half the protein in the diet of people in the region. Milkfish farming is an important industry in the Philippines, but many fish farmers are constrained by the limited supply of milkfish fry with which to stock their ponds. The leaders of the research team, Einstein Lavina and William Vanstone, used a hormone extract from the pituitary gland of Canadian salmon to stimulate female fish to produce eggs.

Less dramatic, but no less significant, was the development 10 years later by Chinese and Canadian researchers of a fish-breeding kit for Chinese carp, the most widely cultivated fish in China and a major source of animal protein in many Asian countries. Induced breeding of Chinese carp has been possible since 1958, but the technique is expensive and inefficient. In a cooperative project, Prof. Lin Haoren, of Zhongshan University in China, and Dr Richard Peter, of the University of Alberta in Canada, developed a system to overcome the inhibitors produced by the female carp's brain during attempts to induce ovulation. The result is a low-cost kit that enables the fish farmer to give the brood fish two quick injections that overcome the breeding problem and cuts the farmer's work in half.

The other half of this fishy equation is to improve the breed. Since 1982, IDRC has been helping to develop a network linking aquaculture genetics projects in Asia with each other and with Dalhousie University in Canada. The aim is to use modern selection techniques to develop fish that grow bigger, better, and faster. Scientists in China, India, Indonesia, the Philippines, and Thailand are studying everything from growing conditions and fish-farming techniques to fish behaviour and resistance to stress, with the focus on the selection and domestication of fish for food.

Early results from network projects have been promising. They have led, for example, to the development of training programs and handbooks for farmers and fisheries officers. Many techniques for selection and breeding developed at Dalhousie University have been tested in the field and incorporated into a number of projects. Another finding is that selected "domesticated" fish really do grow faster than their wild counterparts — meaning that aquaculture systems should be based on fish bred for the farm

if they are to be able to expand to meet the rapidly growing demand for more animal protein to feed the peoples of Asia.

Mills Meet Village Needs

The village could be almost anywhere in Africa south of the Sahel, a collection of small buildings, many of them with thatched or corrugated metal roofs, surrounded by a dozen or more of the tall baobab trees that dot the plains. In the shade of one huge tree, a group of men sit talking, discussing politics, perhaps, or the weather, or the state of the crops. In a nearby clearing, four women are working, pounding grain in two large mortars made from hollowed-out blocks of wood. The pestles that rise and fall rhythmically are big, heavy clubs, twice the size of baseball bats. Two of the women have babies slung on their backs and, as they work, all four sing in time to the hollow pounding of the pestles in the mortars.

A picturesque scene, certainly. But these women are not having fun, they are making the best of a bad job, a back-breaking job that takes them several hours just to prepare enough meal for the day. The grain they are processing is probably locally grown sorghum or millet. Both grow well in this semi-arid region, withstanding both poor soils and drought. Until recently their only alternative, if they could afford it, was to buy commercially prepared meal, usually made from imported maize, rice, or wheat.

IDRC has long supported research into postharvest technology, and one of the earliest of such projects was the development of small-scale grain mills that would relieve women and children of the time-wasting chore of preparing meal by hand and, at the same time, support local farm economies. A pilot mill in Maiduguri, Nigeria, was developed in 1974 around an abrasive disk dehuller designed at the National Research Council of Canada's Prairie Regional Laboratory (PRL), forerunner to the Plant Biotechnology Institute (PBI) in Saskatoon, Saskatchewan.

The research was taken up in Botswana, where consumers were delighted with the flour made from machine-dehulled sorghum. Soon, the technology was adapted to create village-level mills that could process individual

Pounding sorghum in a Botswana village — back-breaking work for women.

batches of grain for customers. By the mid-1980s, a small-scale milling industry had been established, with more than two dozen mills in operation. There is even a Mill Owners' Association that lobbies the government on issues such as the pricing and supply of sorghum, and publishes its own newsletter.

One of the limitations of the dehuller, however, is its size. To be part of an economically viable mill, it should be located within walking distance for a population of 8 000 to 10 000 people. So, a mini-dehuller, also designed at PRL, was introduced and modified in a number of projects. Again, the technology has been well accepted, and the two types of dehullers are now in use in mills in 18 countries on the African continent. They have also been adapted for use in India.

Freed from the labour of pounding grain, many of the village women in these regions have been able to turn

to more rewarding activities, often benefitting the local economy. Not surprisingly, some have even been able to overcome social barriers and become mill managers or owners. In some cases, small mills are community owned and managed by village committees. In these situations, too, the women who are the primary users of the mills are playing increasingly important roles. The long-term socioeconomic impact of introducing the dehuller may prove to be far more profound than the original researchers had expected.

Keep the Bush, Forget the Fallow

For centuries, farmers in the tropics have practiced a simple but effective form of agriculture variously called slash-and-burn, shifting cultivation, or bush fallow — simply cut and burn the vegetation to make a clearing large enough to grow the crops you need. The resulting "field" is good for a few growing seasons, then you move on to another area and repeat the process. When the ground has laid fallow for some years, the soil is replenished and the process can be repeated.

The critical factor is the fallow period. If it is too short, the fragile soil becomes degraded and soon will no longer support either agriculture or forest. In Africa, where an annual population growth rate of over 3 percent is placing tremendous pressure on the land, shifting cultivation has become one more contributor to the disaster of deforestation. But the technique has been used over the centuries for a good reason — it works, and one African researcher reasoned that there must be a way to take the best features of shifting cultivation and combine them with modern techniques to get the best of both worlds.

This researcher was Biauw T. Kang, and it was his work at the International Institute of Tropical Agriculture (IITA) in Nigeria that led to the development of a technique now known as alley cropping. In Kang's system, the food crops are grown in 6-metre wide "alleys" between permanent hedgerows of shrubs or small trees. The hedgerows are pruned regularly, and the clippings are used as mulch or green manure, or even as animal fodder. As a bonus, the use of shrub legumes such as the

fast-growing leucaena actually increases the nitrogen available in the soil and, on sloping land, the hedgerows help to prevent erosion.

The concept was tested at IITA with support from IDRC, using continuous plantings of a range of staple crops such as maize, cassava, cowpeas, and rice. The studies showed that not only was it possible to completely eliminate the fallow period, but the soil in the "alleys" actually improved significantly as a result of the repeated additions of prunings from the shrubs. Although it was designed as an alternative method of cultivation for small farmers, the system has also been shown to be effective on a larger scale. It can also be used in combination with livestock, such as goats, to increase productivity even further.

The concept spread quickly and, in 1986, IITA hosted an international workshop on alley farming, attended by 100 scientists from 21 countries. One of the recommendations of that workshop was that an international alley farming network be established to enable scientists to exchange information and results regularly, and eliminate duplication of effort.

Neat rows of young bean plants promise a bumper crop in the alleys created by leucaena hedgerows in Nigeria.

Early in 1989, the Alley Farming Network for Tropical Africa (AFNETA) was established with major financial support from the Canadian International Development Agency (CIDA) and technical support from IDRC; it has since attracted funding from other donor agencies. AFNETA has 22 member countries and, in addition to serving as an information channel, it provides for training and collaborative research with both national and international programs.

Acid Soils in Vietnam

The war in Vietnam saw the devastation of large tracts of mangrove forest in the Mekong Delta and the virtual destruction of an intricate system of earthwork barrages, dykes, and retaining walls. The resulting drop in the water table exposed shallow iron pyrite deposits to atmospheric oxidation, causing a build up of sulphates and sulphuric acid and the progressive acidification of the topsoil.

Attempts to re-excavate the canals and bring the area back into cultivation after the war have only made matters worse by exposing further pyrite deposits and allowing acidified water to spread into adjacent, still fertile tracts. Some 1.8 million hectares — an area almost the size of Wales or Massachusetts — are now affected by serious soil acidification.

SAREC has lent its support to an extended project set up in 1987 in collaboration with the University of Can Tho (the regional capital of the Mekong Delta area, 95 miles from Ho Chi Minh City) with the goal of finding solutions to these problems. One effect of this collaboration has been a radical shift in attitude among the authorities in the area. From a determined "the acid soil problem must be eliminated!" approach — if need be with large-scale engineering projects, for instance — official thinking has turned to considering ways of making use of the land as it is.

Thus, a large part of the project is devoted to learning more about acidophilic plants and their possible uses as well as ways of improving the soil through cultivation.

There have been a number of tangible results. Although the native tree genus *Melaleuca* was known to

do well in acid soils (a fact confirmed by the project), it had never been used for anything but construction scaffolding. The wood was neither suitable as fuel nor of the right size to be used in building. The Vietnamese also believed that the manufacture of paper pulp from *Melaleuca* chips was impossible, a belief confirmed by scientific reports from Australia and France.

Not having seen those reports yet, the Swedish project partners, the Department of Cellulose Technology at the Royal Institute of Technology in Stockholm, went ahead with their own trials — with positive results. *Melaleuca* chips were admirably suited as raw material for paper pulp, with characteristics not unlike those of birch!

Their success was simply explained: the *Melaleuca* samples collected in Vietnam had been left lying for a time before being sent on to Stockholm to be shredded and boiled — long enough for the various volatile oils in the wood (which were the cause of the problem) to evaporate. For the local paper industry, which has always had difficulty in obtaining raw materials in sufficient quantity, the possibility of using *Melaleuca* wood in paper pulp manufacturing would be a significant advantage.

The project followed up the *Melaleuca* success with the construction and installation of a paper pulp laboratory in Can Tho, where the leaves and wood of other acidophilic plants are now tested for their potential suitability in paper manufacturing. Researchers are also experimenting with a range of possible cash crops, including a sugarcane variety that thrives in acid soils and is suitable for animal fodder.

Rural Development and the Environment

The issues that affect agriculture and the environment involve us all; however, it is the rural people who are affected first and most directly. Population pressures in rural areas contribute to many of the environmental problems, such as deforestation, soil degradation, and water pollution. Solutions to these problems will be effective only if the rural people themselves are involved in programs of development on a scale that they can comprehend.

The elements of such programs include reforestation, developing safe and productive farming and food-processing systems, providing alternative sources of employment through appropriate rural industries, and, of course, establishing a reliable water supply. Research to provide such programs involves many different disciplines and is sometimes painstakingly slow because, to be successful, it must also involve the community.

But, as the projects described in this section demonstrate, the results are often catalysts for a whole range of development activities — some not even anticipated by the original researchers.

Water Buffalo in Sri Lanka

Water buffalo, first domesticated in Southeast Asia over 4 000 years ago, remain a vital asset in this part of the world, especially in small-scale farming where the animals not only serve as the poor man's tractor but also produce calves, milk, and fuel (dried dung). Despite their crucial role, water buffalo have until now received only scant attention from agricultural researchers. This is particularly true of the swamp buffalo — the species found in Sri Lanka.

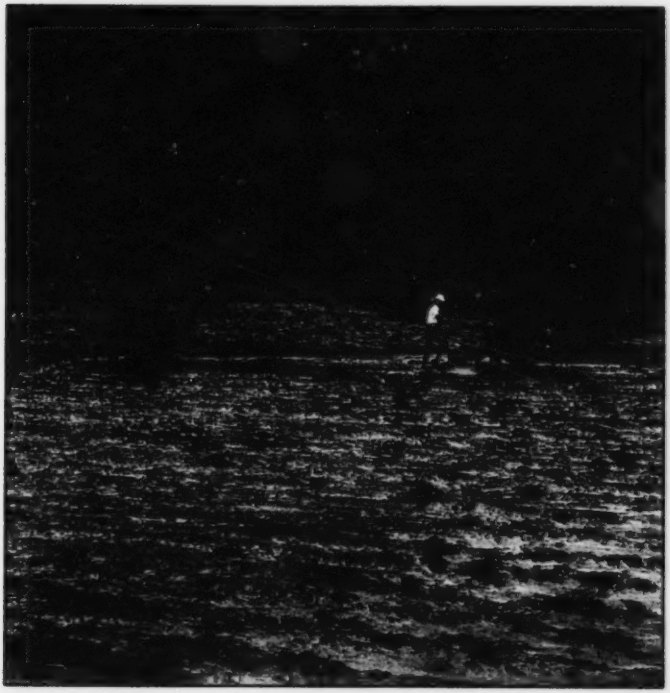
In 1978, the International Atomic Energy Agency (IAEA) funded a pilot water buffalo study program in Asia, with Sri Lankan participation. Shortly afterwards, Sri Lankan researchers contacted SAREC and, in 1983, a broadly based research program on the swamp buffalo was set up in collaboration with the Swedish University of Agricultural Sciences.

Sri Lanka is estimated to have just over half a million water buffalo, the majority concentrated in the rice districts where the fields are ploughed and prepared for cultivation in the time-honoured manner. The researchers initially identified a number of problems requiring urgent attention. These included a variety of diseases, low birth-rates, high calf mortality, and low milk yields. A number of subprojects, many of them involved in basic research, were soon under way.

According to an evaluation carried out in 1988, the program has made a vital contribution to the training of indigenous researchers and the development of research techniques in the field. A great deal more is now known about the health and reproduction of the swamp buffalo.

Detailed nutritional studies have revealed that water buffalo frequently suffer from mineral deficiencies. Lack of phosphorus — a result of soil exhaustion and dwindling pasturage — is a major problem: cows have more difficulty conceiving, which means they produce less milk. A promising line of study is a possible diet supplement in the form of crushed, phosphorus-rich stone, found locally, as a substitute for expensive imported supplements (or none at all).

The main causes of the high mortality rate among newborn and young calves have been established, and work on finding suitable medical remedies is now well



under way. Genetic studies suggest that the Sri Lankan buffalo is not a true swamp buffalo as was previously thought, but is more closely related to the river buffalo. This discovery could have important practical implications for breeding strategies aimed at improving the strain and boosting milk yields.

The researchers have also begun work on new ways of intensifying buffalo-assisted farming management, including a new yoke designed to transmit traction forces more efficiently, thus allowing farmers to plough with a single buffalo where two were needed before. This and other innovations remain to be tested under field conditions — out among the country's small farmers.

Paulownia — China's Wonder Tree

Paulownia is an unremarkable tree to look at. Tall and straight when mature, with a large leafy crown, it is susceptible to floods, to attack by insects, and to disease. But, in its native China, it is called a wonder tree — Premier Deng Xiaoping even called it a treasure. Tens of millions of the trees are springing up on farms all over China. Yet, less than 20 years ago, the tree was virtually ignored. What changed that and brought about this remarkable greening of China was a casual request from Argentina, and the dogged persistence of a forest ecologist named Zhu Zhao-hua.

The Chinese Minister of Forestry, attending the 1972 World Forestry Congress in Argentina, was asked by some Argentineans if he could supply them with seeds of two rare *Paulownia* species. Back in China, he delegated the request to Zhu, who admits he knew very little about the tree at that time. He has since become the country's leading *Paulownia* expert, and is now a senior scientist at the Research Institute of the Chinese Academy of Forestry.

In the process of tracking down those seeds to send to Argentina, Zhu learned a lot about *Paulownia*. He found that the tree grows very fast: a 5-year-old tree might reach a height of 17 metres and have a trunk 30 centimetres in diameter. He also learned that, when grown alongside agricultural crops, *Paulownia* seemed to increase yields; that the leaves of the tree made good fertilizer; and that young branches could be used as animal fodder. Zhu was encouraged by the Minister to continue his investigations. That wasn't always easy, especially during the period of the Cultural Revolution. But he persisted, digging into ancient documents, some dating back as much as 2 300 years, travelling through 19 provinces, talking to the local people, and collecting samples.

Zhu published his findings often, and his work did not go unnoticed. A national *Paulownia* research group was founded and, in 1979, the Academy asked Zhu to undertake a major *Paulownia* research project. Six research stations were established — one for each of the country's principle climatic zones; from here, millions of high-quality root cuttings have been propagated and distributed to farmers. A root cutting planted in the spring will be a 6-metre sapling by the end of the season!

In 1983, IDRC added its support to Zhu's work, enabling members of the research team to obtain specialized training and to continue selecting species most suitable for mass replication. The IDRC-supported work also included experiments on intercropping different species of *Paulownia* with a variety of food crops and studies of the effects of the trees on microclimate.

These studies have shown that intercropping *Paulownia* with wheat at the right density improves yields and soil fertility, protects both the soil and the crops from drying winds, increases humidity, and reduces air temperature. *Paulownia* can also be intercropped successfully with maize and a variety of vegetables. It will even increase the yields of cotton crops in dry weather. If properly pruned, it can also be used to provide timber and fuelwood. A wonder tree indeed.

In 1985, Zhu became the first recipient of the international Man of the Trees Award in recognition of his work. But his real reward is the knowledge that the dissemination of the best *Paulownia* clones is going ahead on a huge scale; already, almost 2 million hectares of China's farmland are intercropped with *Paulownia*.

The Power of the Pump

Clean, safe drinking water is one of the keys to good health. Millions die every year — most of them children — as a result of diseases related to contaminated drinking water. To provide drinking water for billions of people in all kinds of terrain requires new, simple, inexpensive technologies that can be adapted to local conditions and will be readily accepted by the local people.

An example of such a technology is the "plastic pump," a radically redesigned handpump that was developed at the University of Waterloo in Canada under the sponsorship of IDRC. In the 15 years since the first prototype pump was demonstrated, this simple, low-cost technology has been adapted and adopted in many countries of Africa, Asia, and Latin America.

Made almost entirely from cheap and universally available plastic (polyvinyl chloride or PVC), the pump is lightweight, easy to manufacture, and, most important

In Sri Lanka, women have been encouraged to set up village workshops to manufacture and maintain the modified handpumps.

of all, easily maintained by the local people. The problem with many of the older pumps, usually made of cast iron, was that they were imported, expensive, and both difficult and expensive to maintain. PVC can be glued instead of welded, making it easy to replace worn parts, and it doesn't rust. Of course, there were some problems — in parts of Africa for example, hyenas would chew on the white plastic pipe at night, mistaking it for bone. Solution: don't use white!

By the mid-1980s, IDRC had sponsored many projects to develop and test the pump in different parts of the world, and there were three promising variations on the original Waterloo design from Ethiopia, Malaysia, and Sri Lanka. The Malaysian pump, called the Unimade, has been one of the most successful variants, and has since

gone into mass production. It was designed by Dr Goh Sing Yau at the University of Malaya, which, with its newly established research and training centre, serves as the hub of a growing worldwide network of handpump research.

But the spread of the new handpumps has involved more than technology. Over the years, the researchers have had to come to grips with a range of socioeconomic impacts resulting from the introduction of the pumps. Perhaps nowhere is this better illustrated than in Sri Lanka, a country with some 23 000 villages, most of them served by unsafe wells. The government realized that introducing handpumps would not succeed unless the people understood the importance of clean water. They gave the job to Sarvodaya, a nongovernmental organization (or NGO) that encourages self-reliance through community involvement in practical development projects. Sarvodaya's technicians adapted the Waterloo design, replacing some parts with wood and leather to ensure that it could be manufactured entirely from locally available materials.

In the villages, Sarvodaya workers first convinced people of the importance of the pumps to their health and their economy. Then they involved the villagers in selecting the sites and installing the pumps. In the second phase of the IDRC-sponsored project, they went one step further. Observing that women were the primary users of the pumps, the Sarvodaya group trained women to install and maintain the pumps, and helped them to establish a network of village-level industries to manufacture most of the parts.

The Sarvodaya movement has won new respect for women, many of whom have expanded their activities to making small tools and doing other maintenance work. The idea has spread to other IDRC-supported pump projects as far afield as Ethiopia, Malaysia, and Thailand, where more and more women are discovering the power of the pump is a welcome alternative to spending hours every day fetching pails of water from polluted wells.

Environmentally Safe Insecticides in Africa

Maize is by far the most important crop in eastern and southern Africa. The harvest is a major factor determining the shape of people's lives in the year ahead. In many years, between a half and a third of the maize harvest is lost to attack by insects. But now, researchers believe they have an answer to this problem that is effective, environmentally safe, and cheap.

Pheromones are chemical substances used in communication between organisms of the same species — part of a kind of olfactory signalling system. For example, some female insects attract males by releasing certain pheromones. Other "scents" signal the presence of tasty plants or warn of predators. A great deal of basic insect behaviour is controlled by pheromones, a fact that goes unnoticed by our insensitive noses.

But what the nose does not detect, advanced research can analyze and duplicate. Today, there are synthetically manufactured pheromones that can be used to control some 50 species of insect pest. In American cotton fields, Japanese tea plantations, and southern European vineyards, environmentally harmless (and considerably more effective) pheromone compounds have supplanted the dangerous chemicals used previously. In Sweden, too, pheromones have been successfully used to control widespread damage caused by the spruce bark borer.

Most pheromone compounds work in the same way: a synthetic pheromone designed to emulate the female insect's "calling" scent is spread over the field. The males, bewildered by this vast display of conflicting information, fail to find a mating partner. The females lay unfertilized eggs and the reproductive cycle is broken.

The technique is remarkably effective and has many definite advantages:

- Sexual pheromones are mainly species specific, that is, they only work with the particular type of insect the farmer wants to eliminate.
- They are completely harmless to the environment, breaking down rapidly and leaving no dangerous residues.
- They are effective at low dosages: a single gram is normally sufficient for an entire hectare.

Cause: the larvae of the maize moth cause great damage in the corn fields of eastern and southern Africa every year.

Effect: typical damage to a corn field that has been infested with larvae of the maize moth.

- Finally, application is simplicity itself: ordinary string is dipped in the pheromone solution and stretched across the field.

The most damaging maize pest is the larva of the maize moth. It eats into the stem, weakening the plant and reducing the yields. Stems may even break off entirely before the maize has had a chance to ripen. Until now, the only effective countermeasure against these destructive pests has been the application of toxic chemicals, which have been too expensive for ordinary smallholders, who account for almost 80 percent of the continent's production of maize and other crops.

Science has finally caught up with the maize moth. After 4 years' intensive SAREC-supported collaboration, the Kenya-based International Centre of Insect Physiology and Ecology (ICIPE) and several Swedish university departments, including the Pheromone Group at the

Department of Animal Ecology at Lund University, are close to isolating the sexual pheromone of the East African maize moth.

The final product should be ready for commercial distribution within a few years. As the patent will not be in the hands of a multinational chemical concern, the compound is likely to be cheap enough to enable smallholders in Africa to combat the maize moth effectively and thereby substantially increase their yields.

Controlling the Chemical Chaos

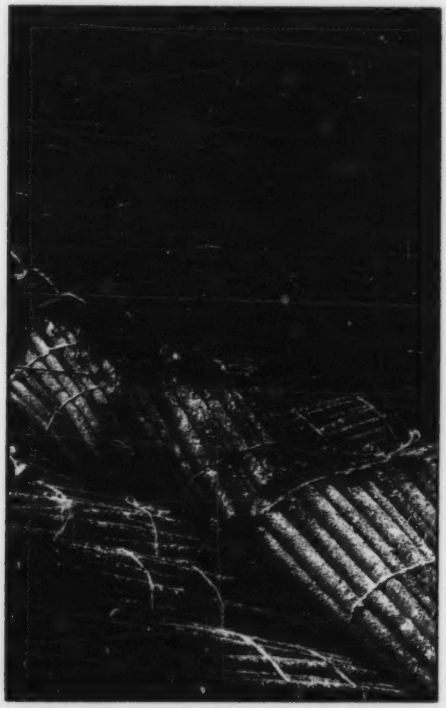
The ghastly consequences of a poisonous gas leak at the Union Carbide plant in Bhopal, India, in 1985 made headlines around the world. The nightmarish toll of dead and injured prompted cries of outrage and condemnation, and rightly so. But the harsh reality is that Bhopal made the headlines only because of the scale of the disaster, involving as it did thousands of helpless people. Every day in the developing world there are "little Bhopals," accidental chemical poisoning that result in injury or death.

Our world has become a chemical smorgasbord. We produce around 100 million tonnes of synthetic chemicals each year, and the amount is increasing. We depend on chemicals for our industries, our agriculture, to wash our clothes, and to control pests. But, can we control the chemicals? The World Health Organization (WHO) estimates that more than 1 million people are accidentally poisoned by pesticides alone every year. In a developing country, perhaps 8 or 9 percent of the victims die. In developed countries, with much higher literacy rates and stricter controls, the death rate is much lower.

What to do? There are more than 60 000 industrial chemicals in production, and many of them are marketed in a variety of combinations formulated for different purposes. Obviously, we are not going to get off our chemical habit in a hurry. The key words are prevention and control: prevent poisonings wherever possible; control the consequences when the inevitable happens — whether that event is a child who has ingested rat poison or another Bhopal.

As part of an international effort to tackle the poison problem, IDRC is participating in the development of a computerized poisons information package for developing countries. The collaborative project is coordinated by WHO's International Programme on Chemical Safety (IPCS), and the Canadian component involves the Canadian Centre for Occupational Health and Safety and the Centre de Toxicologie du Québec.

Many developing countries, particularly those that are undergoing rapid industrialization, have begun to establish poison-control programs and facilities. IDRC is also supporting a number of these national centres with the aim of providing models for other countries to follow. The poisons information package will enable such centres to quickly diagnose and treat poisonings. A database running on an inexpensive microcomputer will provide



In Senegal, a farmer applies pesticide to his millet store — more than a million accidental poisonings.

complete information on known generic chemical substances, as well as case data on poisonings. Users will be able to add information about specific chemical products that are available in their region. Available in English, French, and Spanish, the package will include training materials and a list of reference documents and textbooks.

The first National Poison Information Centre (NPIC) in southeast Asia was established in Sri Lanka in 1988 with support from IDRC. The Centre is based in the Colombo General Hospital and is widely used. According to a recent survey, 75 percent of physicians know of the NPIC; 41 percent of them said they had used its services during the first 2 years.

The Sri Lanka Centre is one of four pilot centres supported by IDRC that are participating in the poisons information package project. Dr Ravindra Fernando, the project leader, believes the experience gained on the project will be valuable not only in setting up other national centres but also in establishing a regional poison information network. He foresees an eventual global system of national and regional centres. Such centres, he says, are an ideal area for cooperation between developed and developing countries in the field of health care.

Bamboo Boom

Is there any plant on earth more versatile than bamboo? You can eat it, cook in it, cook on it, use it to make furniture, fences, and fishing poles, build a house with it, or assemble bamboo scaffolding to build an office tower. Bamboo is used to make everything from clothes to curtains, from tools to toys. With a little know-how you can even make paper from it. And, as if that weren't enough, the obliging bamboo grows so fast you can almost see it sprout — as much as 4 feet in a day according to some reports!

Bamboo and its look-alike cousin rattan represent a major natural resource in South and Southeast Asia, with the value of finished goods running into billions of dollars. So, it's not surprising that when bamboo and rattan showed signs of overexploitation and short supply in recent years, it raised serious concern among govern-

Rattan seedlings at a research centre in Malaysia — nurturing a neglected resource.

ments in the region. And none too soon, for it soon became apparent that the versatile pair were very much a neglected resource. Scientists were forced to admit that they really didn't know a great deal about them. Since the 1970s, however, the situation has changed dramatically, and for the better.

One of the first steps was a seven-country workshop on rattan held in 1979. This workshop led to the establishment of an IDRC-supported rattan information centre at the Malaysian Forest Research Institute. The centre classifies, stores, and disseminates information on the cultivation and use of rattan, and publishes a quarterly research newsletter. IDRC also supported another project at the Institute to develop tissue culture techniques as a new method of propagating rattan. The process could help overcome the problems caused by a scarcity of mature seed-bearing canes in a country where the rattan industry employs at least 50 000 people.

China produces about one-third of the world's bamboo, but even that doesn't come close to meeting demand. A bamboo research station has been established at the Sub-Tropical Forest Research Institute in one of the major bamboo-growing regions of the country. Supported by IDRC, the Institute is working to increase bamboo production by intensive cultivation of natural stands, and by selecting fast-growing, cold-resistant varieties from the

more than 300 species that grow in China. IDRC has also supported similar research in Thailand and Bangladesh, one of the poorest and most densely populated countries in the region, where a scarcity of bamboo had resulted in high prices that affected house-building and devastated many cottage industries.

Researchers at the Bangladesh Forest Research Institute set out to increase the supply of high-quality bamboo in the villages and the state forest areas by developing new cultivation and management techniques. A key feature of the project was the involvement of the villagers, for the researchers knew that without their cooperation the new techniques would not be adopted. Ten villages participated in the research, creating a two-way flow of information from the scientists to the villagers and back to the scientists, an exchange that eventually led to the production of a village-level manual on bamboo cultivation. The project also provided practical training for research staff, resulting in a core group of experienced researchers.

Putting Technology to Work

Appropriate technology used to mean "low tech," as if advanced technology was somehow not needed in the developing world. Today, it means exactly what it says: technology that is appropriate, whether it be a computer or a brick — what is important about technology is that it be accessible to those who need it and that it be well adapted to do the job required of it.

In thinking about technology in the context of developing countries, it is as well to remember that much of the basis of the industrialized world's technology — from the wheel to algebra to engineering — originated in those same "developing" countries. Yet, today, only about 10 percent of the world's estimated 4 million researchers come from the nations of the South.

This section describes several projects that are attempting to enlarge this scientific community through communication and training, as well as some examples of practical applications of "appropriate" technology.

Information — the Essential Tool

A farmer in the Andes harvests his first crop of a new variety of potato. In an African clinic, a doctor administers a new treatment to a sick child. In southeast Asia, a sociologist interviews a woman about her family's use of the

village water supply. What these people have in common is that they're all contributing data to research projects.

Isolated bits of data, once they have been tabulated, analyzed and interpreted, add up to information — reports, studies, papers, proceedings, and so on. Information is the researcher's most valuable tool. Without it, time and money may be wasted following up fruitless leads or duplicating research that has already been done. In the developing world, where everything is scarce, trained researchers are a precious and limited resource to be used for maximum benefit.

The problem is not that there is a shortage of information, rather the reverse — the difficulty lies in finding relevant and timely information among thousands of reports and results. This is where the computer comes in. Computers process information at unimaginable speeds and, in the past decade, they have become both robust and affordable, so that the ubiquitous computer terminal can now be seen in research organizations in almost any country in the world. But computers are only as good as the programs that drive them. Software is the key.

Students receiving MINISIS training in Tunisia — part of a unique community of computer users.

Fifteen years ago, the computer revolution was just beginning, but IDRC recognized the importance of the computer as a vehicle for sharing knowledge and transferring technology. The Centre began a project to develop a software tool that would allow organizations in developing countries to manage their own information efficiently and to exchange information with the rest of the world. The tool is called MINISIS and, today, it is the basis of a unique community of computer users in both the developing and developed worlds.

More than 350 organizations have licenced the software, which runs on the popular Hewlett-Packard HP3000 series of minicomputers. A new version will soon be available for low-cost, DOS-based microcomputers. In an unusual arrangement, the software is made available at no cost to developing-country organizations; elsewhere, MINISIS is licenced through commercial distributors. About two-thirds of the licencees are in developing countries.

MINISIS is versatile. It can operate in different languages, using any of five character sets, and even users with only rudimentary computer skills can quickly learn to use it to search for information on thousands of topics. Computer specialists can use the software to develop their own specialized information tools. Many of these applications are made available to other MINISIS users through the User-Contributed Library. Users also share databases and ideas, both informally and through regional meetings. Regional MINISIS Resource Centres provide training and assistance, and IDRC publishes a newsletter and sponsors international users' group meetings.

Many international organizations also use MINISIS and, at IDRC, it is used as a bibliographic tool in the library, as well as to administer the Centre's many mailing lists. The Inter-Agency Development Research Information System (IDRIS) is a MINISIS application that was developed in 1983 by IDRC in collaboration with five other international research funding agencies, including SAREC. It provides a pool of information about research projects in the Third World, with the aim of encouraging cooperation and coordination. Today, there are nine participating agencies, and many others have access to the more than 6 000 records in the system.

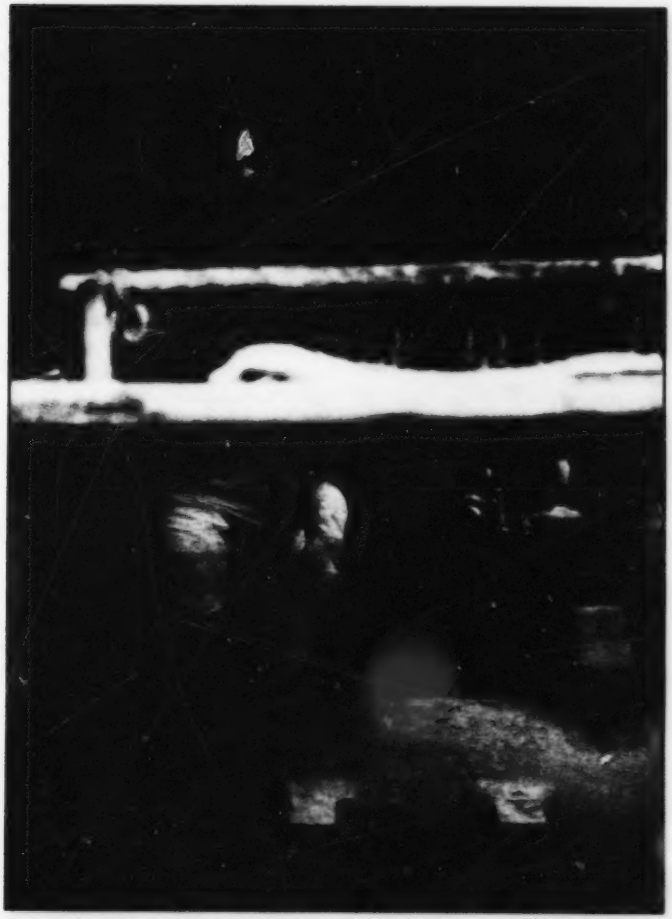
Gold and Theoretical Geology in Nicaragua

When the Sandinista Revolution took power in 1979, gold mining in Nicaragua had been an established industry for more than 400 years. Despite this, there was little prospecting and extracting know-how within the country — for the simple reason that all mining operations had been in the hands of foreign companies that brought their own technology with them.

The country did not, for instance, possess a single assay office; all mineral samples were taken away for analysis in the United States. The acute shortage of professionally qualified staff was further aggravated by the exodus following the revolution. Thus, in 1980, the number of Nicaraguan geologists employed by the Ministry of Mining stood at three, only one of whom had extensive working experience.

For several years, moreover, in response to the "uncertain" political situation in the country, mining companies had refrained from gold prospecting altogether. By 1980, ore reserves in the country's largest gold mine, El Lime, were barely sufficient for another year of mining.

Improved prospecting methods have led to the discovery of new deposits of gold ore in Nicaragua.



Improving the enrichment process means extracting more gold from the ore, with obvious benefits.

Given these circumstances, initial SAREC support focused mainly on technical issues — through the Swedish Geological Company (SGAB) — rather than on development research cooperation.

The first task was to investigate and draw up recommendations on ways of setting up and equipping a mineral-analysis laboratory. The laboratory itself was financed by SIDA (the Swedish International Development Authority) and completed by the beginning of 1983.

The next step was to determine the most effective methods for continued gold prospecting in Nicaragua. The results obtained here were applied in subsequent prospecting operations (financed by SIDA), which very quickly led to new gold finds.

Efforts to improve prospecting techniques have continued, combined in some cases with research into better methods of grading the different types of gold ore being discovered. As a result, a great deal more is now known about the probable sites of gold deposits and about elements that normally indicate their presence.

A third project studied ways of improving the enrichment process at the El Lime mine. Its recommendations regarding adjustments to or renewal of existing plants and equipment were subsequently implemented with support from SIDA. Returns from the mine have since risen by several percentage points, corresponding to an annual profit increase of 2 to 3 million Swedish krona at normal rates of extraction (6 Swedish krona = 1 United States dollar). The search for better enrichment techniques continues and has been extended to other smaller mines throughout the country.

Since 1983, SAREC has also funded work on the so-called geological traverse, an ambitious project with many basic research characteristics. The work involves detailed geological, geophysical, and geochemical studies conducted along a 30-kilometre wide belt stretching from coast to coast. Although not yet complete, the survey has already yielded useful information on probable sites of mineral, gas, and oil deposits. On the theoretical level, the survey has generated large amounts of data that will help to provide a better understanding of the region's geological history and the movement of the Central American "Cocos" plate.

The new data will also help scientists to predict and interpret earthquakes — a common occurrence in the region — with greater accuracy; and the special tectonic plate charts drawn up during the project will allow seismologists to pinpoint more reliably areas at risk from earthquakes.

SAREC's support in these project areas has also contributed to the enhancement of domestic capacity and experience. To date, seven Nicaraguans have completed their higher education in geology and mining technology in association with one of these projects.

Botanical Research in Ethiopia

The end of the 18th century in Europe saw an awakening of interest in the idea of a systematic description of the plant world. Contemporary advances in agriculture and the accelerating development of industrial technology exposed the inadequacies of the old, muddled classifications. With the publication of Linnaeus' *Systema Naturae* in 1735, outlining a binomial classification scheme for organisms, a new system for identifying and naming plants at last became available.

Linnaeus' principles received rapid and general acceptance. For the first time, botanists everywhere enjoyed the advantages of a common scientific language. As a result, botanical research made rapid progress during the 18th century; along with organic chemistry, it was to play a vital role in the coming industrial revolution and the continued development of agricultural technology.

However, systematic classification was mainly applied in Europe and (eventually) the United States. Other lands only attracted attention when they became of interest to colonizers as a potential source of wealth. Thus, it was not until the end of the last century that comprehensive mapping of native plant life was carried out in areas like Africa. One country that has remained untouched by any such recording activities, however, is Ethiopia, which was never colonized — a fortunate circumstance that, at the same time, deprived any colonial power of the incentive to invest in botanical research. Nor did the country succeed in developing a corresponding research capacity of its own.

This state of affairs remained practically unchanged until 1980, when, with SAREC's support, the University of Addis Ababa and the Department of Systematic Botany at Uppsala University started up a joint project for map-

ping the Ethiopian flora. Project aims, apart from a comprehensive survey of all plant life in the country, were to furnish the Addis Ababa herbarium with a complete collection of indigenous plant species and promote botanical research in Ethiopia.

This extensive project is not expected to be complete before the year 2000. One reason for this is the unusually large number of plant species in Ethiopia (approximately 8 000 — five times as many as in Sweden) and the fact that new, previously unrecorded species are continually being discovered as the work proceeds. Another complicating factor has been the internal political situation.

The study of the Ethiopian flora is also of substantial interest to international botanical research. Although many African plant species have been described on the basis of specimens collected in Ethiopia, determining family relationships without a complete picture of each species in its Ethiopian context has long been a problem.

Several important cultivated species, among them coffee, wheat, and barley, are believed to have originated in Ethiopia, where they still occur in greater genetic variety than in other countries. More detailed knowledge

This yellow flower of the genus Bidens *is used in religious and social contexts in Ethiopia; it has medicinal qualities, among them the ability to control bleeding.*

of these plants could be of considerable benefit to plant breeders elsewhere, for example, in developing varieties that can withstand drought or are more resistant to certain common diseases.

The first of eight planned volumes of the Ethiopian flora was published in 1990. The contents of the volume include the super-family Leguminosae (including the pea and bean families, and several species that are of paramount importance to Ethiopian farmers). The work, which was printed in Ethiopia and gives for each species both its botanical Latin and common (local, Ethiopian) names, is suitable for use both in scientific work and in the field.

All the Ethiopians who have pursued higher education courses under the auspices of the project have returned to Ethiopia and are now taking part in botanical research work and the continued expansion of the national herbarium. Ethiopia is now regarded as one of the most advanced countries in Africa in the field of systematic botany.

Physics for Everyday Use in Tanzania

Windows that, although untinted, ward off the heat of the sun; simple plastic containers that draw water from the air on clear nights in areas with low rainfall. These are two promising applied physics projects developed by Tanzanian and Swedish researchers. Supported by SAREC, they are part of a joint program involving the Physics Institute at the University of Dar es Salaam and the Chalmers University of Technology in Gothenburg with additional support from the International Science Programs at Uppsala University.

Today, windows used for protection against solar heat are constructed on the so-called wavelength selectivity principle. The glass is coated with a thin metal film that is transparent to visible heat (what we call sunlight) but reflects invisible heat (infrared radiation). By this method, it is possible to cut in half the amount of heat entering a building.

If further reduction is required, for example, to avoid the need for expensive air-conditioning equipment, other techniques must be used. One idea currently being tested at the University of Dar es Salaam is to give the metal coating a special structure that makes the window transparent when viewed face on but increasingly opaque at higher angles of vision. This property, known as angle-selectivity, means in practice that the higher in the sky the sun is, the fewer visible and invisible rays are able to pass through the window. For people in the room looking out — or for someone looking straight in — the glass remains transparent at all times.

Unfortunately, this type of glass remains difficult and expensive to manufacture and windows of this kind would probably have to be imported into most developing countries for a long time to come (assuming they were to be manufactured commercially). However, the project has led to a marked improvement in local research capacity as well as closer contacts with researchers elsewhere in Africa.

The other applied physics project seems more likely to lead to a technology that can be produced easily and cheaply in developing countries. It utilizes the principle of "passive cooling."

The Earth not only absorbs heat from the sun but also radiates some of it back into the atmosphere. This heat is prevented from dissipating into space by cloud cover and by the atmosphere itself. The concentration of carbon dioxide and water vapour in the atmosphere determines how much of this heat is absorbed and reflected back to the ground. However, at certain wavelengths, the reflective capacity of the atmosphere is extremely poor; on a clear windless night, radiation at these specific frequencies can escape through the atmosphere, never to return.

Radiation at these wavelengths thus encounters what researchers call an "atmospheric window" a theoretical confirmation of what farmers the world over have known from time immemorial: on a starry, windless night, crops can be damaged by frost, even when the air temperature is several degrees above freezing.

This phenomenon can be used both for cooling and to condense water. All that is needed, as recent trials conducted in the drier regions of Tanzania show, is a simple and inexpensive plastic container that allows ground heat of the desired wavelength to pass through. The upper surfaces of the container are cooled to the point where the water vapour in the surrounding, relatively warmer air condenses into water droplets, collects on the "lid," and runs into the container. The device creates its own dew point.

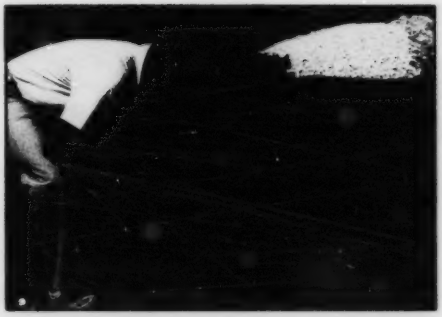
The amounts of water obtained in trials is small — about 400 millilitres per square metre per night. But, given its low cost and simplicity, the method offers considerable potential. For example, it could be used to supply water to small primary health clinics in remote areas. Provided the apparatus proves durable, there will be no shortage of conceivable applications.

Making the Most of Mud

What do you do with 2 million tonnes of slippery red mud? Two million tonnes every year, that is. It's a problem that experts in Jamaica have been trying to solve for years, but now it looks as if they may have a solution to the mud problem that will help solve another of the island's pressing problems — a housing shortage.

The tourists who flock to Jamaica's beaches from all over the world rarely see much of the interior of the island. So, they don't see the lakes of red mud that are dotted among the green hills. Nor do they see the rural villages, where, too often, families of 8 or 10 are crowded into tiny, ramshackle houses, and community facilities such as schools and clinics are either nonexistent or overcrowded and dilapidated. As the rural population grows, so does the housing problem. Most building materials must be imported, making new housing impossibly expensive for the rural poor.

Those same tourists are probably unaware that Jamaica is the world's third-largest producer of bauxite, the rusty red clay from which aluminum is produced. Aluminum, the shiny metal that is used in everything from chewing gum wrappers to jet aircraft, is one of Jamaica's



At the edge of a lake of bauxite waste in Jamaica, researcher Dr Arun Wagh shows how the mud bakes in the sun to a hard, red clay.

main sources of revenue. But the by-product of the process is red mud, and almost 2 million tonnes of it is dumped into old mine sites and natural valleys every year by the companies that mine the bauxite and produce the aluminum.

The possible link between the two problems — the surplus of mud and the shortage of low-cost housing materials — came about as a result of an IDRC-supported study in the early 1980s. A research team headed by Dr Arun Wagh of the University of the West Indies (UWI) studied the composition and properties of the red mud waste and discovered that, when dried in the hot Jamaican sun, the mud turned into a remarkably hard and durable clay. They also discovered that something had to be done to reduce the waste because of the danger of caustic material seeping into local groundwater and contaminating water supplies.

A second IDRC-supported project began in 1986. Involving UWI, the Jamaica Bauxite Institute (JBI), Canada's University of Toronto, and, significantly, the aluminum-producing companies on the island, the project's goal was to find practical ways to make bricks from the red mud — bricks that could be produced locally with very little energy or transportation cost and used to build rural houses and schools.

Given Jamaica's sunny climate, that might sound easy — just pour the mud into moulds and let it bake in the sun. Unfortunately, the mud showed a tendency to bake hard on the outside but remain viscous on the inside. The researchers studied a range of bonding materials, from natural fibres to fly ash left over from burning sugar-

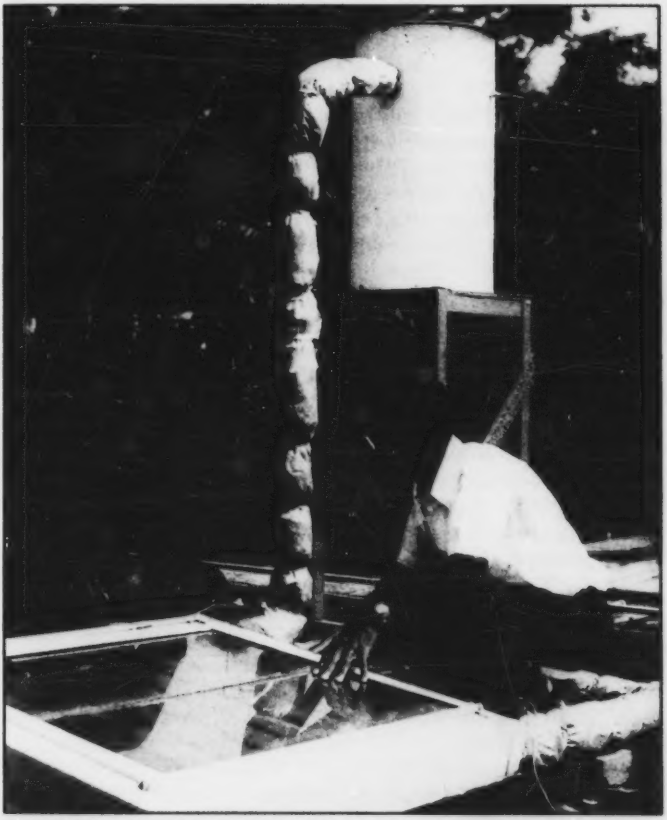
cane bagasse. They developed prototypes, tested them to ensure that the final product would meet building code standards, and built a model brick home at JBI to demonstrate the efficacy of the new material. Already, the researchers are looking at other applications, such as the manufacture of floor and roofing tiles, and water and sewage pipes.

In a related IDRC-supported project, a local NGO called the Construction Resource and Development Centre (CRDC) is using the bauxite bricks to construct cyclone-resistant housing in several communities around the island. There's even another bonus: local people are being trained by CRDC in production of the bricks, and the process could eventually create a sizable rural industry providing much-needed employment for the rural poor.

Solar Power Provides Drinking Water

In southern Africa's Kalahari Desert there is little rain, and much of the groundwater is saline — too salty to drink. The Kalahari covers four-fifths of Botswana. It is a harsh and inhospitable land, and conditions have worsened in recent years as a result of a series of droughts. Consequently, previously nomadic peoples like the Basarwa, who once roamed the bush, have formed permanent settlements. The only source of drinking water for many of these communities is a government tanker truck that delivers a supply every few weeks, when it can get through at all.

In an effort to find a less expensive and more reliable way of providing potable water to these "remote area dwellers," researchers from Botswana's Rural Industries Innovation Centre (RIIC), with support from IDRC, have turned to the region's most readily available natural resource — the sun. Khawa is one of the communities that participated in an intensive 3-year trial of the solar technology; here, the people have enthusiastically joined in a project to use the sun's energy to desalinate the water they get from their wells.



Simple solar stills like this one in Botswana can produce up to 8 litres of drinking water daily — enough for a family of four.

The desalinators glitter against the desert sand a hundred metres beyond the settlement, looking oddly like two rows of squat, miniature greenhouses. In northern climes, they might be used by gardeners to give their seedlings an early start on a short growing season. But, here in the Kalahari, daytime temperatures can reach 45 degrees C; inside the little greenhouses, it gets hot enough to heat water to 75 degrees C. These are solar stills, each capable of producing up to 8 litres of water daily under ideal

conditions — not much, but enough for the drinking and cooking needs of four people.

The stills are remarkably simple in design. A fibreglass basin, coloured black to absorb the sun's heat, is fixed to an insulated pad on the ground and covered with two sheets of ordinary window glass. The glass is sealed and there is a circular, airtight hatch at each end. Saline water in the basin evaporates, the water vapour is trapped on the glass, droplets run down into gutters at either side, and the gutters lead the water into a holding tank. A very small amount of saline water is added to this distilled water to provide the mineral content that is required.

Less simple, however, was the introduction of a new technology into the desert dwellers' society. The RIIC researchers wanted the community to be involved directly in building and maintaining the stills so that they would accept ownership and responsibility for their new water supply. Water, and the question of who controls it, are sensitive issues in the desert, however. In some communities, the researchers had to overcome suspicions and divisions among the people to get them involved in the project. Even after the stills were shown to operate successfully, the problem of social organization continued to be a critical variable in the water equation.

Critics say the simple stills are not as efficient as more advanced technologies such as reverse osmosis desalinators. However, these advanced technologies are expensive, must be imported, and require skilled service technicians. The RIIC sees the solar stills as a partial solution suited to certain conditions, and hopes to expand the program to use the stills in community schools and clinics.

Teedzani Woto, a sociologist who heads RIIC's Extension Department, says "Desalination should not be seen as an end in itself, but as a means to an end. . .as a way of creating a base for other development initiatives in a settlement."

Support for National Research Training

An increasingly important aspect of SAREC's bilateral work is support for research training, an activity especially relevant to African projects. The most common practice has been to integrate training of indigenous researchers within the research project itself. Most of the projects based on collaboration with a Swedish university department provide for training in this way.

In recent years, however, SAREC has increased support for basic research training at a number of developing-world universities not directly connected with a particular project. In this way, training can be extended to larger numbers of researchers, an important precondition for establishing a functioning, broadly based national research environment.

A notable example of this model is the Master's Degree training program at the University of Addis Ababa in Ethiopia. The faculties currently involved in the program, which was begun in 1980, include Science, Engineering Sciences, Medicine, Pedagogy, Social Sciences, and Humanities. To date, 600 students have passed the degree examination.

Nationally based research training has a number of advantages over training received abroad. To begin with, degree candidates tend to become engaged in research areas of direct importance to the country's development. While studying they can also assist university lecturers — usually in short supply — with the teaching of undergraduate students (in the medical faculty, they can even attend to patients). Finally, their dissertations can serve as useful study material, an otherwise scarce resource.

After obtaining their degrees, the vast majority of students remain in the country, contrary to the usual practice of researchers wholly trained abroad on foreign scholarships. With the large number of trained researchers made available as the result of the Master's Degree program in Ethiopia, the government set up postgraduate, doctoral courses in biology and chemistry at the University of Addis Ababa (with substantial assistance from SAREC) in 1986. Only 3 years later, the first batch of postgraduate students to successfully submit their dissertations received the first ever doctorates to be awarded at an Ethiopian university.

Between 1980 and 1987, SAREC allocated support to virtually all the disciplines encompassed by the Master's Degree program. Since 1988, however, SAREC has focused its support on six fields: biology, physics, chemistry, geography, road and water supply technology, and electricity. Research of this kind requires an expensive infrastructure. An undertaking on this scale thus presupposes the concentration of available support funds. It is hoped that this kind of venture will link the Master's Degree training program within these areas to national postgraduate education in engineering sciences and pure science.

The Human Side of Science

Technology provides the tools for development, but it is people that make development happen. The social sciences and the humanities are vital aspects of research in support of development, for it is economics and politics that determine science policy and the direction of development programs. Wise and informed policies can do much to smooth the process of transition that many developing countries are going through.

Many of the obstacles to change are rooted in hundreds of years of tradition. Motivating change in such societies requires sensitivity based on understanding. Researchers must first understand the underlying reasons for people's attitudes if they are to succeed in introducing new ideas, new ways of doing things.

This section describes several projects in which researchers found new ways of motivating people, as well as support for research in the humanities, too often neglected in the push towards development.

Research in Aid of Democracy in Latin America

The 1960s was an era of reform and relative democracy for large parts of Latin America. Social science research blossomed and debates extended far beyond the walls of academe. It was also a period of incipient economic crises and political insurrection, a time when established ideas and institutions were brought into question and broad segments of the population began to demand an end to poverty and social injustice.

This period, however, was to prove brief. Political tensions ran high and the increasing polarization rapidly manifested itself in armed confrontation. By the mid-1970s, most of the countries in Latin America were ruled by military dictatorships that systematically detained, tortured, and executed political dissidents. The number of politicians and intellectuals forced into exile grew rapidly. As a result, Latin American research in the social sciences was threatened with extinction.

It was in this context that a few international agencies made special efforts to ameliorate the effects of repression. IDRC's institutional funding to nine research institutions in Argentina, Chile and Uruguay from 1977 to 1986 enabled a core of social science researchers to remain working in their respective countries. This was complemented by a special Latin American program initiated by SAREC in 1977 aimed at supporting "critical development research in countries where these activities are inhibited by prevailing political and economic conditions." SAREC's support was extended to two principal recipient groups:

Poster pays tribute to the Christian Democrat Patricio Aylwin, the democratic opposition's joint presidential candidate in the Chilean election.

Election rally in Santiago, Chile, in December 1989 — social science research has supported the struggle for democracy in several Latin American countries.

- Independent scientific institutions able to continue their activities under some form of diplomatic protection (for example, from the United Nations or the Catholic Church) despite the repression, and
- Centres of scientific activity in other Latin American countries that had become important focal points for researchers driven into exile.

The aim was twofold: to prevent the collapse of research in the social sciences and to contribute through continued activity to the advancement of democracy. A total of 30 research centres and some 250 researchers benefitted from the program; in a great many cases, this support was to be decisive for their continued survival.

According to an assessment carried out by independent researchers in 1985, SAREC's Latin American program fulfilled its objectives satisfactorily. The research undertaken was held to be of a consistently high quality and its orientation, for the most part, was relevant to conditions in the countries concerned.

Activities in several centres have exercised an influence on official policy discussion within their respective countries and helped to keep the issues of democracy and the social consequences of economic policies on the political agenda. A number of these centres — CIEPLAN (Corporación de Investigaciones Económicas para Latinoamérica) in Chile is a notable example — have also played a central part in the transition to democracy and supplied basic data, derived from their research work, for new economic policies.

Although the military dictatorships have departed, SAREC's Latin American program will almost certainly continue, with a somewhat altered strategy. The political and economic situation in the majority of the countries concerned is still too unstable for research in the social sciences to sustain its current capacity without outside help.

Social Soap Opera

The serialized television drama, better known as the soap opera, is the most popular type of program in the increasing number of developing countries where television is widely accessible. For the illiterate majority in such countries, television has become their main source of information. This makes television, and the soap opera in particular, a formidable tool for social change.

If important social messages can be incorporated into popular programs such as soap operas, people may be persuaded to make changes that benefit them as individ-

Visiting doctor examines village children in Egypt — can soap operas combat disease?

uals, and society as a whole. Those who study techniques of mass communication call it "social value reinforcement." In the 1970s and 1980s, the Mexican Institute for Communication Research developed a number of "social" soap operas promoting such values as literacy and responsible parenthood. In the words of the researchers, the soap opera "produces a significant increase in the practice of behaviour associated with the promoted value." For example, when two soaps promoting family planning were aired, sales of contraceptives in Mexico increased by 23 percent.

Egyptian television viewers love their soap operas. A recent survey showed that 95 percent of homes have television sets, and 92 percent of viewers regularly watch Egyptian soaps, many of which are also avidly followed by viewers in neighbouring countries such as Jordan and Morocco. Since 1983, this huge audience has also viewed more than 60 "commercials" made by the Center for Development Communication (CDC) in Cairo. The commercials, always broadcast during the most popular soap operas, deliver important health messages. One series, promoting oral rehydration therapy to combat diarrhoea in children, was described by the British Medical Journal as possibly "the world's most successful health education program." The Journal credited the campaign with saving the lives of 100 000 children. Other themes include immunization, breast-feeding, hygiene, and sanitation.

Now, the CDC is planning an even more ambitious project — producing its own social soap opera that will

promote a more realistic view of Egyptian society, as well as incorporating many of those same health messages. IDRC, in collaboration with the Ford Foundation and Johns Hopkins University, is supporting the experiment. Communications researchers from Jordan and Morocco are also involved, making this a television production for the region.

The first 15 episodes of the series are currently being scripted. A preliminary version of each episode will be pretested on selected audience groups and, during the broadcast period, studies will be conducted in all three countries to evaluate the impact of the series. The stories will revolve around a dedicated doctor who maintains a practice in Cairo as well as in his former home village, where he does his best to help the rural people and overcome village superstitions.

The series will contain many serious messages. Egyptian women and children, particularly those in rural areas, face many health problems. Too often these result in death, yet one recent study noted that "most of the deaths were attributable to causes that are preventable." Preventing those deaths by weaving examples into the stories is what the new soap opera will attempt.

The researchers hope that the new ideas will take on a life of their own as viewers' attitudes to traditional practices change and that the series will soon become popular enough to be self-sustaining. For the producers, the writers, and the actors, it's a tall order. But, given the immense popularity of television soap operas in the region, the series may well be a real winner.

The Historical Archives in Mozambique

Researchers in the industrialized world have access to a host of libraries and museums in which to seek historical source material, each with a long tradition and a well-defined field of activity. Source material is meticulously catalogued and easily accessible.

These are resources that we take for granted. Few of us give much thought to the immense significance of such institutions as the repositories of our national heritage.

Only when they are not available, as in Mozambique, does their importance become apparent.

During more than 400 years of colonial rule, every official document drawn up in Mozambique was sent to Portugal, the mother country. Although a historical archive was formally set up in Mozambique in 1934, very few documents were actually deposited in it; most official material continued to be sent to Portugal and dispersed among a number of separate archives.

When Mozambique became independent in 1975, the Historical Archives' total collection contained no more than 1 000 running metres of official documents and books, most of them lying in random, uncatalogued stacks on the floor. The institution's equipment consisted chiefly of an antiquated typewriter. The staff — with the exception of the director, whose real work was at the university — lacked suitable training.

The new government of Mozambique quickly resolved to build up the archive: it authorized new premises, hired better qualified staff, and backed an intensive, nationwide effort to gather in documents from the colonial period. Negotiations with Portuguese authorities were begun with a view to gaining access to those archives containing the bulk of the historical material.

The work on the Historical Archives was financed to a large extent by development aid. From 1979, much of this aid was provided by SAREC.

Today, the Archives' collection comprises 20 000 running metres of documents and books, of which a proportion has now been catalogued and the remainder roughly sorted. A large number of books on Mozambique have been acquired. In an extended systematic search through archives in Portugal, some 30 million pages of historical documents were transferred onto microfilm, for which reading projectors have now been supplied.

Another of the Archives' four departments has carried out a large number of interviews with the country's older inhabitants to record and preserve oral history. Another project is concerned with collecting and cataloguing old sound material from the former colony's radio stations.

Although the Archives is still chronically short of resources, it is now a functioning institution employing

The Great Zimbabwe culture — vestiges of a capital city that is estimated to have had over 10 000 inhabitants in the middle of the 13th century.

trained, experienced staff and capable of providing important source material for current and future research projects.

New Archaeological Approaches in East Africa

The science of archaeology is central to all historical research in Africa, where written records are rare and human history stretches further back in time than anywhere else on Earth.

But archaeology, as it was practiced on the African continent during the colonial period, was characterized by a somewhat narrow, distorted approach. In East Africa, for example, archaeologists either concentrated on the early stone age — when civilization was still at an early stage of development — or devoted their energies to study-

ing the relics left by the early colonizers. No attention was directed to the long intervening stage, with periods characterized by highly developed East African cultures.

Archaeologists also tended to assume that the history of African civilization began with the arrival of Europeans. Anyone showing interest in the "wrong" avenues of research was in danger of being silenced. Thus, the white minority government in what was then Rhodesia censored archaeological reports on the Great Zimbabwe culture, an advanced civilization whose capital city in the 13th century had an estimated population of 10 000.

With independence, the countries of East Africa turned their attention to filling in the vast uncharted areas left on the archaeological map by colonial researchers. This enterprise has proved an interesting challenge for African and international research alike.

SAREC began contributing funds to archaeological research in East Africa in 1987, following the establish-

ment of a joint research project involving the universities of Maputo and Stockholm. The aim of the project was to compile basic data for a new textbook on the history of Mozambique, with special reference to the period before the arrival of the Portuguese. It was not long before the Swedish Board of National Antiquities was also drawn into the project, which by then included an inventory of archaeological remains and a number of excavations. Begun at about the same time (1980), was a collaborative project with Somalia, in which Swedish archaeologists helped train local staff and took part in the digs.

Both projects worked well and produced some interesting results. In the Manyikene district in Mozambique (about 450 kilometres northeast of the capital city of Maputo), archaeologists unearthed a previously unknown city inhabited by people of the Shona culture between about 1200 and 1650 and thought to be an offshoot of the Great Zimbabwe culture. Meanwhile, the excavation in Somalia of a 700-year-old mosque furnished new clues to the origins of the capital Mogadishu and its relations with the outside world in precolonial times.

In recognition of the success of these projects, the Board of National Antiquities held a conference in 1986, attended by delegates from seven East African countries. The participants drew up guidelines for a major regional research project on "urban origins." As yet, no one has come up with a satisfactory explanation of the hows and whys of this process; the question has traditionally been answered by reference to Arab traders who supposedly founded the (coastal) towns for use as trading posts.

However, new archaeological evidence points to both pre-Arab influences and the existence of far more developed cultures in the East African interior than was previously suspected. Project researchers have cited evidence of contact between the coastal towns and several large settlements in the interior.

Thus, according to one conjecture, the foreign traders, far from founding the coastal towns, were instead attracted to the area precisely because of the flourishing domestic trade already established. If so, what were the relations between the coast settlements and the interior? How were the various communities organized and how far did they extend? What factors led to the rise of the cities in the first place, whether on the coast, the islands, or in the interior?

The questions are many and complex. However, researchers have already come up with a number of partial answers under the auspices of a project that today embraces Botswana, the Comoros, Kenya, Madagascar, Mozambique, Somalia, Tanzania (including Zanzibar), and Zimbabwe. With the help of new methods, from satellite pictures to microdrills and electrical measuring instruments, archaeologists are beginning to piece together a picture of the cities at different periods, their size, and their lifetime. The new microdrill sampling technique developed during the project has since been used in excavations at Birka, in (Lake) Mälaren, near Stockholm.

The large number of African researchers and doctorate students taking part in the work and the many scientific reports and papers already written are signs of a long-suppressed interest in the questions the project addresses. This may also be the explanation for the project's success in unifying the archaeological institutions of so many African countries — all of them poor and still bearing the imprint of three separate colonial powers — into a functioning scientific enterprise.

The final results, due to be presented before an international archaeological conference in East Africa in 1992, promise to be exciting and no doubt will have a profound effect on the writing of African history.

Schools where Teachers don't Teach

A 10-year-old girl stands at the front of a class of two dozen younger children. The "classroom" is an open-sided structure with a thatched-palm roof. She holds up a card with a single word printed on it. No one volunteers to read the word, so she spells it out and pronounces it for them. Another card. This time several hands go up at once. She points to a boy near the back, and he reads the word on the card correctly. Very good, she smiles, and the little children clap. Next card.

The girl with the cards and the wide grin is Rosita. She is a student at the school, but every day she spends part of her time teaching — helping the younger children learn to read. The school is in a village in the Philippines, and there are many other unusual things about it.

Student teaching younger students at an IMPACT school in the Philippines — a model of educational innovation.

Imagine a school where teachers no longer teach classes; instead, they supervise learning. A school where children learn at their own pace, alone or in groups, working from instructional modules. A school where the older students help to teach the younger ones, and adult volunteers provide instruction in crafts and other skills. A school where children attend because they want to, and adults are welcome to come and resume their own education.

This unconventional vision of a learning environment was the brainchild al most 20 years ago of a group of educators at INNOTECH, the Regional Centre for Educational Innovation and Technology. INNOTECH is one of several regional centres created by SEAMEO, the Southeast Asian Ministers of Education Organization. That vision has since become a reality. In the Philippines, it is called Project IMPACT; in five other countries, it goes by different names, and has been modified in many ways to meet differing cultures and needs.

In many Third World countries, there is a critical shortage of resources for education: too few teachers, too little money, not enough books or equipment, or even buildings. In rural areas, the situation is particularly bad

and, because children must often take time off to help on the land, many never complete even the elementary grades. This was the situation that the original Project IMPACT was designed to remedy — how to deliver improved primary education to more children at lower cost.

The first two projects were begun with IDRC support in 1974 in the Philippines and Indonesia (where it was called Project PAMONG). Early results were positive, and the projects attracted the attention of other international agencies, including Unesco, UNICEF, USAID, and the World Bank. With additional support, the experiment spread. By 1982, there were school systems based on the same model operating in Bangladesh, Jamaica, Liberia, and Malaysia. Some of the researchers who had helped develop IMPACT and PAMONG brought their experience to other countries. For example, INNOTECH's Dr Orlando Claveria was project leader when the IMPACT model was introduced into schools in Bangladesh in 1982.

Despite promising results, indicating reduced costs and satisfactory academic achievement, not all the projects have met with equal success. In Jamaica, all the IMPACT schools have reverted to conventional methods. Liberia's internal problems have affected the entire education system. Some of the best results were obtained in the Philippines, yet there has been a reluctance to expand the system on any large scale. In Indonesia, however, more than 400 schools are using variations of the PAMONG method and, in Bangladesh, officials are projecting 500 schools using a system very similar to the original IMPACT model.

Everywhere it has been tried, this adaptable experiment in education delivery has brought fresh thinking and new ideas to the surface. If the nations of the Third World are to meet the basic educational needs of their growing populations, they will have to be innovative. Project IMPACT provides a model on which effective educational innovation can be based.

About the Collaborators

This section provides brief descriptions of IDRC and SAREC, including their organizational structure and programs of support for Third World research. Additional information can be obtained by contacting the agencies directly:

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What is IDRC?

The International Development Research Centre (IDRC) was created in 1970 by an act of the Canadian Parliament to provide funds and expert advice for development-related research in Third World countries, according to their individual needs and priorities. The Centre is entirely funded by the people of Canada and reports directly to Canada's Parliament. An autonomous organization, it operates under the direction of an international Board of Governors. Seven members of the Board are from developing countries served by IDRC.

The Centre operates on the premise that the greatest understanding of a country's problems comes from within the country, and that solutions must be appropriate to its people, resources, culture, priorities, and aspirations. The Centre supports projects that are identified, designed, conducted, and managed by researchers in developing

countries. In its first 20 years, the Centre supported some 2 000 such projects.

IDRC works with people — those people who will be affected by the research activities the Centre funds are often involved in gathering the information on which the projects are based, as well as in their design, implementation, and evaluation. This ensures that the research reflects both local and national needs and goals. Developing countries are encouraged to draw on the knowledge and experience available within their own scientific communities. Canadian scientists who are involved in IDRC projects are colleagues — not visiting experts — working in collaboration with developing-world scientists and sharing with them new ideas and techniques.

The Centre's decentralized structure reflects its commitment to strengthening research and development within the Third World. Headquarters are in Ottawa, but IDRC's regional offices cover the developing nations of Africa, Asia, Latin America and the Caribbean, and the Middle East. Regional staff assist researchers in preparing proposals, monitor projects, and provide a support network for researchers and policymakers in their region.

IDRC has seven operational divisions:

- Agriculture, Food and Nutrition Sciences,
- Communications,
- Earth and Engineering Sciences,
- Fellowships and Awards,
- Information Sciences,
- Health Sciences, and
- Social Sciences.

Agriculture, Food and Nutrition Sciences

The programs of the Agriculture, Food and Nutrition Sciences Division (AFNS) support projects that focus on the small farmer and the rural poor and promote improvements in crop and animal production methods; integrated resource management; increases in the quality and quantity of livestock; pasture improvement; improved forest management and forest product utilization; aquaculture and small-scale fisheries; better methods of food processing, handling, and storage; and testing village-level food and agricultural methods. In cooperation with other IDRC programs, AFNS also supports research in nutrition and

agroecology, with an emphasis on promoting sustainable agricultural systems.

Communications

IDRC uses scientific research as a tool for development; Communications programs seek to ensure that this research benefits people. Activities supported fall under three broad categories: experiments in the dissemination and utilization of research results; studies on how communities can participate in the research process; and research on communications systems and technologies. To provide the communication tools needed for the implementation, dissemination, and utilization of research results, the Communications Division also carries out translations, print and audiovisual production, and public affairs programs.

Earth and Engineering Sciences

Technology is one of the keys to change in the developing world; but, to be useful, it must be tailored to the realities of local needs, materials, and cultures. The Earth and Engineering Sciences Division emphasizes innovations or improvements to existing products and processes in close collaboration with small and medium-sized enterprises; the aim is to create jobs and increase the value of local resources. There are also programs to support research on the constraints of different soil structures in land use for construction; the exploitation of underground water resources; small-scale mining; the use of natural rocks as fertilizers; and construction materials and techniques for low-cost housing.

Fellowships and Awards

IDRC's Fellowships and Awards programs, which build indigenous research capacity, are available for projects and programs, as well as to developing-world institutions in which IDRC-funded activities take place. One scholarship program brings young civil servants to Canada for training in public administration and management. In addition, support is offered for specialized training and to young Canadians embarking on careers in international development research.

Information Sciences

A basic tenet of all research and decision-making is that it is only as strong as the information on which it is based. Programs of the Information Sciences Division (IS) help improve systems, services, and skills for managing and using information about economic, social, environmental, industrial, technological, scientific, and related issues. They also support the development and testing of appropriate information tools and technologies in the fields of telematics, informatics, remote sensing, cartography, statistics, and information storage. IS provides two specialized information services from within IDRC: MINISIS, which is a versatile, multilingual, bibliographic software applications package, and the Centre's library, which is a valuable source of information on the developing world, serving IDRC staff, those involved in IDRC-supported projects, and other researchers concerned with international development.

Health Sciences

The community is at the heart of IDRC's Health Sciences programs. It is at that level that the elements responsible for health interact: illness, poverty, environment, and policy. One program examines how human behaviour, as influenced by local circumstances, affects susceptibility to disease and can increase risks. Health-care systems are studied within another program with special emphasis on training and managerial needs. The many physical, chemical, and biological factors influencing well-being are examined within a program including research in health and the environment.

Social Sciences

In the broadest terms, the aim of IDRC's Social Sciences programs is to help societies gain a deeper understanding of the development process and of its impact on people and institutions. Social science research seeks ways for people in the developing world to have adequate shelter, to get an education, to understand family planning, to find work, to use efficient transit systems, to live in a cleaner and safer environment, to adapt new technologies to their

needs, to resettle after war or natural disasters, and to participate in decision-making at the community or state level.

What is SAREC?

The Swedish Agency for Research Cooperation with Developing Countries (SAREC) was founded in 1975 and now operates as an independent government agency under the Ministry for Foreign Affairs. The Agency receives a little more than 3 percent of the total Swedish government allocation for overseas development assistance. SAREC's 1991 budget is equivalent to 70 million U.S. dollars. SAREC is guided by a 12-member Board of Governors, most of whom are senior academics.

SAREC operates on the premise that there is an urgent need in developing countries for research that is directly relevant to local problems and that, whenever possible, this research should be conducted by local scientists. Simply put, the Agency's mandate is to support research that contributes to the development of developing countries. More specifically, SAREC funds international research projects that can help to solve important problems in developing countries; it helps developing countries to build their own research capacity; it also promotes scientific cooperation between Sweden and the developing world, and among the developing countries themselves. SAREC supports research in 15 countries in Africa, Asia, and Latin America.

In the early years, 90 percent of SAREC's budget went to support international research programs. Today, the emphasis is on bilateral research cooperation, particularly with the least-developed countries. This means focusing both on actual research projects and on support for national institutions, enabling them to better identify and define appropriate topics for research, to plan and carry through research projects, and to create stable research environments. Bilateral programs in more developed countries tend to be more focused on achieving research results.

Direct cooperation between research institutions in Sweden and those in developing countries is an important way of building research capacity. This type of institutional cooperation also gives developing-country researchers opportunities for additional training. In 1991, SAREC supported about 170 institutional research cooperation activities involving more than 120 different Swedish university departments and other research institutions.

Certain important areas of research that are not covered under bilateral programs are supported as special programs. These include maternal and child health, democracy and human rights, and research on women's issues. The Swedish government has also allocated funds specifically for certain areas where the need for research is perceived to be urgent — such as deforestation, desertification, and the AIDS epidemic.

SAREC also supports regional research institutions in developing countries, and research projects where several developing countries work together to form collaborative research networks. Support is also provided to international research programs — such as the Consultative Group on International Agricultural Research (CGIAR) and several World Health Organization programs in the fields of tropical diseases, primary health care, and human reproduction.

To encourage interest in development research among Swedish scientists, SAREC acts as a research council. Support for development research at Swedish universities accounts for about 10 percent of the Agency's annual budget.

SAREC's headquarters are in Stockholm, with a staff of 40. In 1987, a regional office was opened in Harare, Zimbabwe, with the aim of monitoring research projects in the region and strengthening contacts with researchers in Southern Africa.

Research activities supported by SAREC can be grouped under four sectoral headings:

- Health and nutrition,
- Rural development and the environment,
- Natural sciences, technology, and industrialization, and
- Social sciences and the humanities.

Health and Nutrition

The health and nutrition sector includes support for research in epidemiology, diarrhoeal diseases, maternal and child health, tropical diseases, health systems, and AIDS. Particularly important areas include epidemiological studies of health problems in the developing world and biomedical research to develop new vaccines and drugs.

Rural Development and the Environment

The sector on rural development and the environment provides support for research on crop management, agricultural technology, biological nitrogen fixation, and marine ecology. Support is also provided for international research programs in agriculture and agroforestry. A 5-year program of research on deforestation and desertification is aimed at building capacity for environmental research at several developing-country institutions, as well as obtaining research results. Environmental issues are also part of many other research activities within this sector.

Natural Sciences, Technology, and Industrialization

Central to the natural sciences, technology, and industrialization sector is support for research collaboration and training for research in Africa. Support is given for research training in Ethiopia at the Master's and Doctoral levels; for energy research through an African regional network called AFREPREN; for research in the field of geology; to the International Centre for Theoretical Physics, to provide training for scientists from developing countries; and to the International Foundation for Science, which helps to reduce the "brain drain" by supporting the work of young developing-country researchers in their own countries.

Social Sciences and the Humanities

The sector on social sciences and the humanities provides support for critical social science research in developing countries. This includes regional programs for social science research in Africa and Latin America; a special

program on democracy and human rights; participation in the African Economic Research Consortium; and a special program of research of importance to women in the developing world. In the humanities, SAREC supports a seven-nation archaeology program in East Africa that is helping to build a regional network of archaeologists.